

# **OPTICS IN LATIN AMERICA. An update until 2005.**

Néstor G. Gaggioli<sup>1</sup>, Argentina, 2005.

## **I - INTRODUCTION**

Twenty years after the first Latin American workshop on optics and twelve years after the first meeting in which Spain and Portugal also participated, it seems opportune to analyze the evolution of the Latin American optical community, to draw out some conclusions and to be aware of which our state of affairs is and which our goals are from now onwards.

The purpose of this short article is twofold, to give readers a brief idea about the state of the art of optics in Latin America and to describe the degree of organization of the optical communities in some of these countries.

After the first isolated activity in Physics in Latin America, Mossotti (1830) and E. Bose (1908), in Argentina or G. Wataghin (1934) in Brazil, there has been a rapid and systematic development since the late 1940s and the early 1950s with a strong governmental support. However, the star was at that time atomic physics rather than optics.

This process of growth in Latin American physics research has induced the active physicists to organize national societies with the goal of fostering academic activities and promoting the scientific community. The oldest of such associations is the Argentine Association of Physics (AFA-1944).

As a result of a proposal from the Brazilian government, accepted by representatives from 20 Latin-American countries at the IX UNESCO General Conference, an agreement was signed on October 3, 1962, as a result of which the Latin American Center of Physics (CLAF) was created. Another main contributor to the development of physics in Latin America is the Federation of Latin American Physical Societies (FELASOFI-1984). Both organizations gave another step, forward when in 1995; the Latin American Network of Physics was created.

Among the physicists working in Latin America there have always been some groups active in optics. However, after the discovery of laser (1959) and holography (1962), research in optics has increased in the region. It was at that moment when the physicists working in optics began to organize themselves in the physical societies.

In January 1947 the General Assembly of IUPAP approve the appointment of a Preparatory Committee to considering forming an International Commission for Optics. The first plenary session of ICO in conjunction with the next General Assembly of IUPAP was held in July of 1948 in Amsterdam. Spain participated since the beginning of ICO (Prof. O. Navascués was the second Vice President, 1950).

After that, the Sociedad Española de Optica (SEDO-1968) was organized. In 1972 the Academia Mexicana de Optica (AMO) was accepted as TC of Mexico; in 1978 the TC of Portugal was accepted, in 1981 the Comité Argentino de Optica was recognized as TC of Argentina; in 1984 the Comité Brasileiro de Optica was admitted as a new TC; in 1990 the TC of Colombia joined the International Commission; in 1993 the TC of Cuba, followed by the TC of Venezuela in 1997.

The first Meeting organized by Spain was held in 1953 in Madrid. The XI Meeting of ICO (1978) was the second Optical Meeting organized by a member of the Iberian and Latin American community (SEDO-Madrid). In that second Meeting those countries presented 37 communications: Spain, 27 (73%); Venezuela, 5 (13,5%); Portugal and Mexico, 2 (5,4%) and Brazil, 1 (2,7%).

Some years later, a group of people working in optics in Latin America made the decision to organize regularly an optical workshop called Encuentro Latinoamericano sobre Optica, Láseres y sus Aplicaciones (OPTILAS). The first Meeting took place in Colombia (1984), the second, in Niteroi, Brazil (1986). The III OPTILAS was organized by Argentina in Mar del Plata (1988); the IV OPTILAS took place in Oaxtepec, México (1993) and the V OPTILAS in La Habana, Cuba in 1995.

These kinds of meetings were not only workshops but also schools of optics and laser where all the assistants played an important role, particularly during the Members Assembly.

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This initiative had another very important motivation, which help the development of the Latin American optical community: the creation of an International School on Optics and Photonics. The first School took place jointly with the first Meeting on Optics, Laser and their Applications (OPTILAS). These Schools happened in the time of the earliest Meetings (1984), until 1993, and sometimes after that year.

The main purpose of these Schools was to provide students and young researchers from the Latin American countries with modern overviews about active areas of research at the frontiers of Optics and Lasers. The programs of the Schools showed theoretical an experimental topics in almost equal proportion.

I believe that these Schools have provided the earliest steps to ease the formidable problems faced by students and scientists in Latin American countries as they attempt to share in the technical and scientific developments that were taking place everywhere.

Another important initiative was the School on "Laser and Optics in Engineering" (LOI). The LOI was originated in 1980. The main goal of this activity was to spread the knowledge of optical techniques in Engineering, quality control services, and developments in Optical Communications. This School was steered by the Optical Research Center (CIOp) of Argentina to all Latin American colleagues and was granted by the National Research Council of Argentina and by the International Center for Theoretical Physics (ICTP) to give some scholarships to students.

In 1992, SEDO organized the I Reunión Iberoamericana de Optica (RIAO). This meeting had the typical characteristics of an optical meeting with oral communications and posters. In 1995 the II RIAO was held in Guanajuato, México.

During the V OPTILAS (1995, Cuba) and the II RIAO (1995, México), the participants decided that from then on, both meetings would be organized together.

In 1998, for the first time, VI OPTILAS and III RIAO were held together in Cartagena, Colombia and the same happened in 2001 in Tandil, Argentina. The next joint Meeting will be held in October 2004 in Margarita Island, Venezuela.

Another important activity started in the 90s, was the development of Networks. Probably the earliest and more important initiative was the Multipurpose Optical Network (MON). This Network started its activities in July 1996. The main purpose was to support the scientific exchange of researchers in the field of Optics and Lasers. To this end, the MON received a generous financial assistance from the Abdus Salam International Center for Theoretical Physics during the last years.

Besides the discussion about a Latin American Optical Society, it is undoubtedly certain that the fact of organizing OPTILAS for 20 years and RIAO for 12 years means that the Latin America optical community is quite developed. Moreover, the fact of agree the organization of both meetings together shows the high level of maturity. Although the possibility of creating a Latin American Optical Society arose in several meetings, we have not reached any conclusions yet. However, always seems the moment to start a serious discussion about this subject.

Now, the engagement of the other Latin American countries is advisable and we must work for this target.

## **II - OPTICS SCHOOLS IN LATIN AMERICA.**

There were many initiatives to provide students and young researchers of the Latin American countries with modern overview about several active areas of research in Optics and Lasers. Among the most important:

### **II.1 - Optics and Laser in Engineering (LOI, from 1980 until now)**

This School was originated first in 1980 on a one-month basis. After two years of earning experience, it was reduced successively to two weeks and finally to one week. Participants were encouraged to employ optics and laser techniques in their current activities. Most of the participants had no previous contact with this speciality. This School was organized by the Optical Research Center (CIOp) of Argentina. The main goal of this activity was to spread the knowledge of optical techniques in Engineering, quality control services, and developments in Optical Communications. Besides, once the participants became involved, the enthusiastically endorse future work, activities, and exchange of

information. Precisely, this attitude contributes to the desires of dissemination of the methodologies learnt in the workshop by the participants in their home institutions, and thus the objective is fully accomplished.

From the academic point of view, the participants got a sounded basis on the laser mechanisms and the techniques of coherent optics.

The Commission for Scientific Research of the State of Buenos Aires (CIC), The National Research Council (CONICET) and The National University of La Plata actively supported the Workshop. The funds provided by these institutions was used to cover fellowships to travel, lodging and miscellaneous purposes of the participants. The International Center for Theoretical Physics (ICTP) started to financial support the LOI activities in 1991 until 2000.

The LOI received approximately 450 participants from Argentina and around 200 from the Latin-American region. Most of the foreign participants were also involved in middle term stays for conducting research activities in the field. Almost all of the Argentine guests were Engineers, but most of the foreign participants were physicist.

## **II.2 - International School on Laser and Quantum Optics (from 1984 until 1993)**

The main purpose of these Schools was to provide students and young researchers from the Latin American countries with a modern overview of several active areas of research in Optics and Lasers. Theoretical and experimental topics were represented in almost equal proportions. These Schools had consisted of approximately 50 hours of lectures by specialists in different fields. Active participation by the students was actively encouraged as one of the most important goals of these Schools, to stimulate exchanges and constructive debates among the participants.

I believe that these schools have provided a first small step to ease the formidable problems faced by students and scientists in Latin American countries as they attempt to share in the technical and scientific developments that are taking place everywhere.

These Schools had received financial assistance of Organization of American States (OEA), Latin American Center of Physics (CLAF), the International Center for Theoretical Physics (ICTP) and the National Research Councils of different countries.

It is possible to evaluate the number of assistant to these Schools in near 30% of the Meeting participants. After 1993, this School took place sometimes jointly with RIAO/OPTILAS meeting.

## **II.3 - Summer School J.A. Swieca on Quantum Optics (1990)**

This School was one of the first National School with international impact. Many Brazilian and Latin American colleagues had attended this School. I have no data about the number of fellowships shared in these schools.

## **II.4 - First Applied Optics School (1998)**

This Optics School was organized by the Brazilian Optical Committee (ICO representative) in the Physics Institute of Sao Paulo University, Brazil. The School was attended by more than 200 fellowships. The purpose of this School was to provide students and young researchers a modern overview of Optics in Technology, Research and Development in Brazil.

## **II.5 - II Winter School J.J. Giambiagi (Advanced topics in Experimental Optics).**

This School was organized by the Physics Department of Sciences Faculty, Buenos Aires University (UBA), Argentina, 2000. Near 70 fellowships had attended the courses. It was a typical post graduated school organized by UBA with the economical support of the National Science Foundation (NSF) and the Latin American Center of Physics (CLAF).

## **II.6 - Quantum Optics (2000 - 2004)**

The first of these Schools took place in Santiago de Chile in August 2000. It provided a forum to discuss many developments in Laser Physics and Quantum Optics with topics such as Non-Linear Optics, Atom Optics (Linear and non-linear), Laser cooling, Atom and Ion trapping, Bose-Einstein Condensation, Quantum Interference, Atom Laser, Quantum Computing, Cryptography, Teleportation, Quantum Theory of Measurement. The School was attended by near 40 fellowships and had received financial assistance of the Latin American Center of Physics (CLAF), the International Center for Theoretical Physics (ICTP) and some Chilean Universities.

The second School happened at Cozumel, Mexico in September 2004 and had provided a forum to discuss many developments in laser physics and quantum optics, such as quantum optical realizations of quantum information processing, trapped ions, atom optics, quantum computing, and quantum state reconstruction among others subjects. This School had received financial assistance from the approximately the same Institutions than the first workshop. I have no well-defined data about the number of fellowships shared in this school; nevertheless we think that there was near 60 participants.

### **II.7 - Andine School of Spectroscopy, 2005**

This School was organized and financed by some Peruvian Universities, Peru, May 2005. It provides a forum to discuss new developments in Spectroscopic Techniques and estimate how is possible make use of these techniques in Latin America. Active participation by the students and scientists is actively encouraged to stimulate exchanges and constructive debates among the participants.

### **II.8 - LATIN AMERICAN SCHOOL OF OPTICS (LASO) (Actually in discussion).**

This School will have a fundamental objective that is the promotion of Optical Sciences among the Science and Engineering graduates of the Latin American Universities. This will serve to demonstrate that it is a way for development and progress, and at the same time a way to a possible quality of life improvement of the citizens in our region, if the countries implement Science support general policies, and in particular, for Optics.

This is due to the countless applications of Optics in areas such as: biotechnology, computing (classical and quantum), biology, spectroscopy, medicine, image formation and treatment, astronomy, architecture, communications, structure design and analysis, chemistry, environmental control and environmental impact measurement of humane activities, art preservation, cultural heritage, monument restoration, ultramicroscopy, nanoscopy, analysis of nanostructured surfaces, optical fibers, solid and amorphous Optics, ultrashort light pulses technology, to cite only those areas, subjects, and disciplines in which Optical applications gain notoriety in the last years.

This School is aimed to professionals and students in all countries that form the area known as Latin America. These countries are: Argentina, Bolivia, Brasil, Chile, Colombia, Costa Rica, Cuba, Ecuador, El Salvador, Granada, Guatemala, Haití, Honduras, México, Nicaragua, Panamá, Paraguay, Perú, Puerto Rico, República Dominicana, Uruguay, and Venezuela.

This means that all members' countries can be in all rights sit of the LASO. Scientists of the above mentioned countries could be lecturers in it, or its students and professionals, participants or concurrent to it.

The School would take place every three years; it would be preferable that it does not coincide with the RIAO-OPTILAS Meeting. The place of realization would be in form of a rotation among the Country members. Preferably, the sits may be chosen among those countries with a well-established research activity.

The ICO Territorial Committees and other optical organizations had not finished according a mechanism to start this School up to now.

## **III - LABORATORY NETWORKS.**

As was remarked above, another important initiative started in the 90s, was the development of Networks. A laboratory network is very important to increase the exchange of researchers as well as the use of optical facilities in those laboratories well equipped by the researchers working with less resources. In this way, it is possible to mitigate the economical problems of our region and it is possible to help to the growth of our research activities.

For that reason since a long time span the Latin American community has created some interesting initiatives with variable success. Among these initiatives are:

### **III.1 - Multipurpose Optics Network (MON).**

The Multipurpose Optics Network (MON) started its activities in 1996 until 2002. The main purpose was to support the scientific exchange of researchers in the field of Optics and Lasers. To this end, the MON received a financial assistance from the Abdus Salam International Centre for Theoretical Physics and from Argentine Science and Technology Institutions. Besides, some Laboratories, Academic Groups and Universities contributed towards the success of the Network with

supplementary assistance. A Selection Committee formed with three academics from Colombia, Brazil and Argentina elected these fellows from a big list of applicants. At present this network has stopped its activities.

### **III.2 - Optical and Laser Applications Network (RAOL).**

This network was created in 1997. Its principal objective was to make advising and to assist to find optical solutions to industrial problems. The Steering Committee of this Network was integrated by people of Venezuela, Uruguay, Brazil and Argentina. Indeed this network never was running in a normal way. It is possible to say that this network has stopped its activities after 2000.

### **III.3 - Other National Networks, between them:**

#### **III.3.1 - Colombian Optics Network.**

This network looked more like a Chapter of the Colombian Physical Society instead of a real network. Nevertheless the Colombian colleagues have developed an automatic e-mail distribution list containing all addresses of integrants of national optical community as other Latin American ICO Territorial Committees. At present this network has evolved in an Optical Society, but I have not more information about this event.

#### **III.3 2 - Argentine Optical Laboratory Network (RALO).**

The Argentine ICO Territorial Committee has been well established as a Division of the Argentine Physics Association and has developed an automatic e-mail distribution list containing all addresses of integrants of the national optical community. We had expanded such system to Brazil and Spain. Now, after three years it has started a real Optical Laboratory Network (RALO).

The Argentine Optical Laboratory Network was created at the beginning of 2003 by a resolution of the community of researchers, professors, engineers, scholarships and students of optics and photonics with the purpose to promote and support joint activities related to this area. More than 200 colleagues working in near 30 optical laboratories of different Institutions and Universities integrate the network. The Network receives the financial support of the National Research Council of Argentina. Some typical activities of the RALO are: to give grants for joint researches, to give funds to organize Thematical Workshops, to give financial support for post graduate courses, to support the bureau meeting of the Territorial Committee, to assist to representative of Argentina for participate in ICO Meetings, etc.

Now we need to explore the different experiences in optical networks developed in some Latin American countries. Probably it is necessary to start Cooperation Programs between two or more countries.

We will stimulate the creation in each country of a Directory of Optical Laboratories with the following data: Name and address of the Laboratory, Name and e-mails of the researchers, PhD students and technical staff, Research Projects, Relevant Equipment, etc. The final target is to have a Latin American Optical Directory.

Finally, it is very important to expand an automatic e-mail distribution list containing all members of the Latin American optical community to have access to all news and can also distribute any notice to the whole community. This initiative will strengthen the relationship among the colleagues of that community and will be very useful to increase the interaction among the different Territorial Committees.

## **IV - THE EVOLUTION OF THE LATIN AMERICAN WORKSHOPS AND THE IBERO-AMERICAN MEETINGS OF OPTICS.**

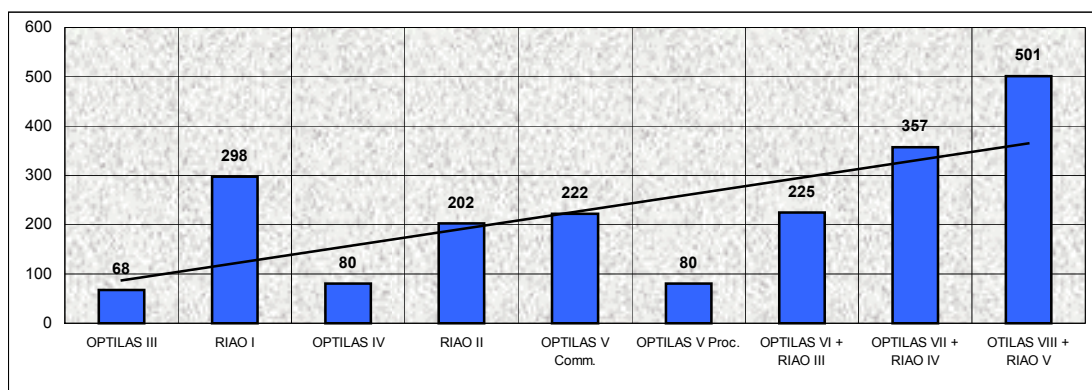
Some colleagues might possibly have information about the first and second OPTILAS workshops, but I only have found data from III OPTILAS on.

It will only be discussed here the number of participants, communications, etc. It is well known that this kind of meetings gives us much more material to be analyzed. However, I will only take into consideration measurable facts and this will lead to some interesting conclusions.

For example, one of the most important contributions of OPTILAS was the course of optics and lasers that helped many young people to improve their knowledge in those subjects. Another valuable contribution of RIAO was the increasing interaction with our colleagues to Iberian Peninsula.

#### IV.1 - Communications presented in OPTILAS and RIAO Meetings.

MEETINGS	COUNTRY	YEAR	COMMUNICATIONS
OPTILAS III	Argentina	1988	68
RIAO I	Spain	1992	298
OPTILAS IV	Mexico	1993	80
RIAO II	Mexico	1995	202
OPTILAS V Comm.	Cuba	1995	222
OPTILAS V Proc.	Cuba	1995	80
OPTILAS VI + RIAO III	Colombia	1998	225
OPTILAS VII + RIAO IV	Argentina	2001	357
OPTILAS VIII + RIAO V	Venezuela	2004	501



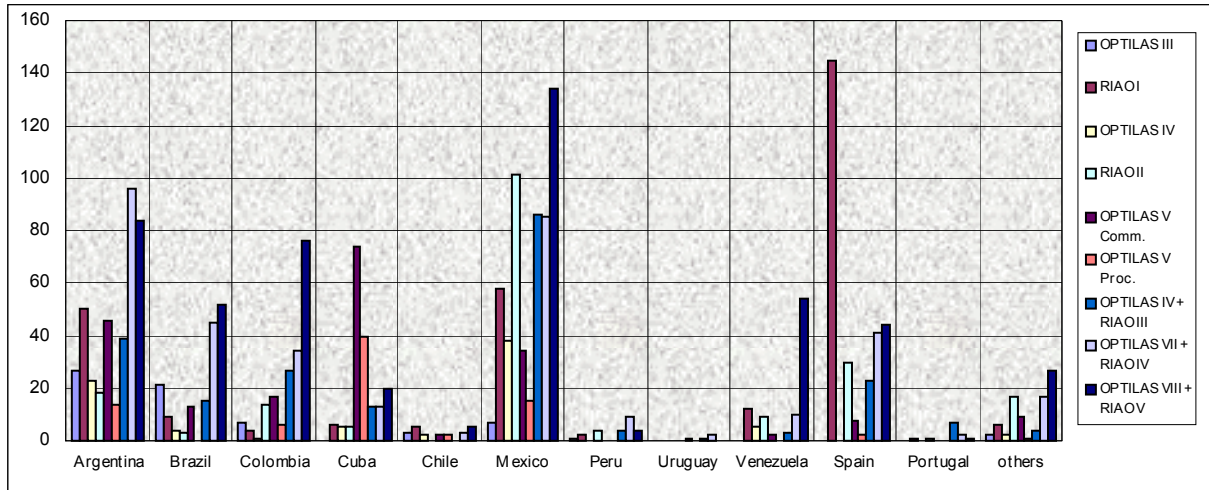
From the amount of communications presented in the meetings, an increase in the contributions of the Latin American optical community can be detected. Anyway, there are some evident local and economical influences: Argentina was the country with the largest number of contributions in III OPTILAS and VI OPTILAS-IV RIAO, Spain in I RIAO, Mexico in II RIAO and IV OPTILAS, Cuba in V OPTILAS in any of both situations: the communications presented or the letters in the proceedings. The only exception was III RIAO, VI OPTILAS and VIII OPTILAS-V RIAO, where Mexico was the country with the largest amount of contribution and not the host country.

In both, the last meeting in Margarita Island, Venezuela, and the last but one, in Tandil, Argentina, the number of communications has greatly increased. In Tandil with reference to the meeting of Cartagena, Colombia, the number of communications was 59% greater, and in Margarita Island was 40% greater than in Tandil.

The association of both events seems to have given a greater significance to these kinds of meetings.

#### IV.2 - Communications by countries presented in both meetings.

MEETINGS	COUNTRY	YEAR	Argentina	Brazil	Colombia	Cuba	Chile	Mexico	Peru	Uruguay	Venezuela	Spain	Portugal	others
OPTILAS III	Argentina	1988	27	21	7	0	3	7	1	0	0	0	0	2
RIAO I	Spain	1992	50	9	4	6	5	58	2	0	12	145	1	6
OPTILAS IV	Mexico	1993	23	4	1	5	2	38	0	0	5	0	0	2
RIAO II	Mexico	1995	18	3	14	5	0	101	4	0	9	30	1	17
OPTILAS V Comm.	Cuba	1995	46	13	17	74	2	34	0	1	2	8	0	9
OPTILAS V Proc.	Cuba	1995	14	0	6	40	2	15	0	0	0	2	0	1
OPTILAS VI+RIAO III	Colombia	1998	39	15	27	13	0	86	4	1	3	23	7	4
OPTILAS VII+RIAO IV	Argentina	2001	96	45	34	13	3	85	9	2	10	41	2	17
OPTILAS VIII+RIAO V	Venezuela	2004	84	52	76	20	5	134	4	0	54	44	1	27



Another interesting conclusion drawn from the communications submitted in these events is that the mean contribution of the majority of countries has increased. Taking into account the last three meetings, the number of communications has increased at the mean rate of 140 per meeting. For example, Argentina, Colombia, Mexico and Venezuela have increased their participation at the rate of 23-26 comm./meeting, Brazil has expanded its participation in 19 communications per meeting, Spain and others (i.e. the authors from outside the region) has increased in 11 and 12 respectively, Cuba and Chile at only 4 and 3 communications per meeting.

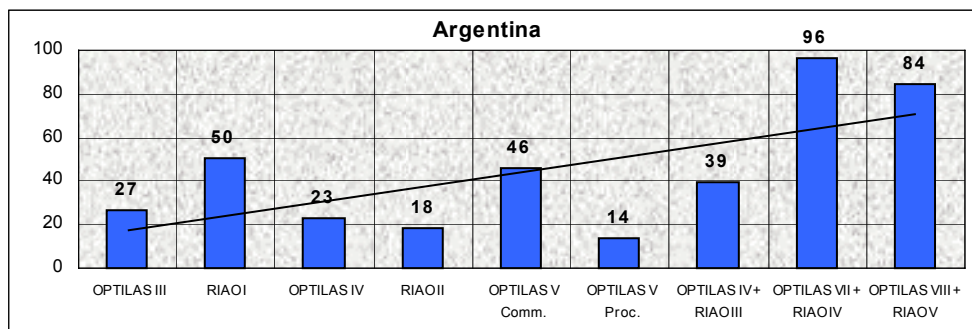
It is relevant to point out the increasing participation of Brazil in these kinds of meetings. This is very interesting for the Latin American community since the Brazilian contribution to optical science is quite important. It is also significant the growth of communications from Colombia and Venezuela, Mexico's leadership and the increasing continuity of communications presented by Spain and Argentina.

In order to have a wider and deeper panorama of the optical activities in the whole region, it is essential to take into account the number of publications from those countries. This will be analyzed later on in this paper.

### IV.3 - Participation of each country in OPTILAS and RIAO Meetings.

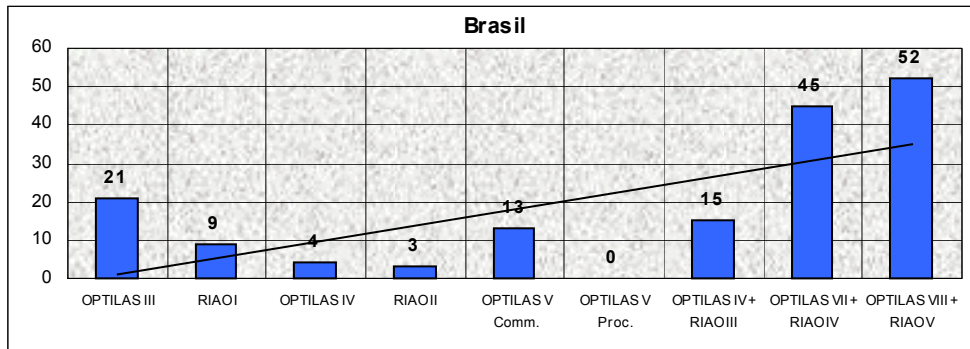
Even if in the last paragraph some words were written about the evolution of the number of communications presented by different countries in the last three meetings, it is interesting to analyze the contribution of each country from 1988 up to now.

#### IV.3.1 - Argentina.



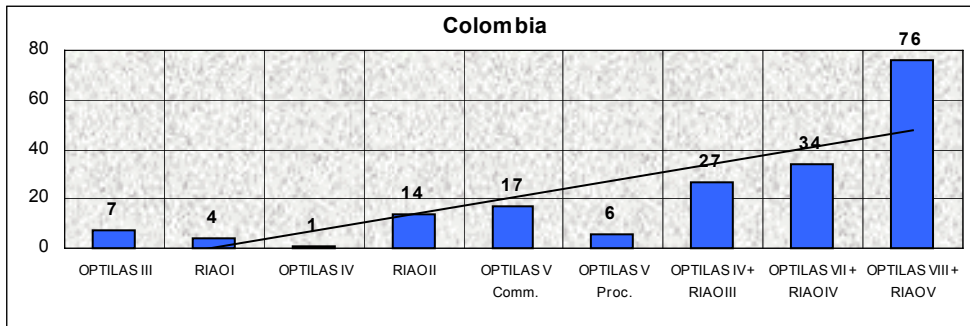
The people working in optics in Argentina has increased from 1988 up to now. The real fact is an increasing in the mean number of communications presented in these meetings. Any way, there are many reasons to explain this. The greater number of people working in optics from 1988 to 2004 in spite of some stagnation in the last ten years and a better training in optical research. It is also important to consider other non-scientific reasons, such as more grants for research, the coincidence with the location of the meeting or the chances to have grants for traveling and accommodation, etc. These non-scientific reasons are also applicable to other countries.

### IV.3.2 - Brazil.



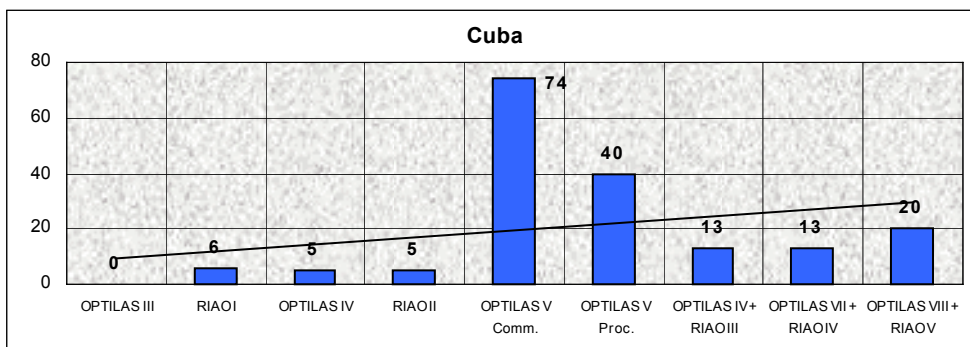
The increase of communications from Brazil has probably two main reasons, one of them is the increasing number of people working in optics and the other is that the Brazilian optical community begins to recognize these meetings as Latin American meetings. Nevertheless, considering the regional leadership of the Brazilian optical community, its contribution to these meetings is still small. We wish its contribution could grow until it has an importance according with the real scientific effort of this country.

### IV.3.3 - Colombia.



It seems highly probably that the increasing participation of Colombian opticians in these meetings has twofold reasons; one of them is the growth of the optical community and the other the increasing level of academic training in optical research. Anyhow, it is possible to imagine the start of this sustained growth in the Cartagena Meeting in 1998.

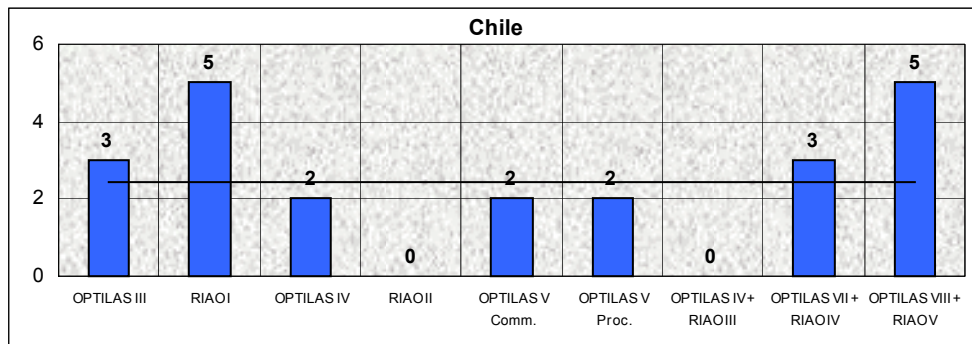
### IV.3.4 - Cuba.



According to our knowledge, Cuba has an important community working in research and development in optics with a high level of academic training. But everybody knows the problems of Cuba, many of them imposed by other countries. Therefore, it is difficult to have a real knowledge of Cuban optics through Cuban participation in these meetings. Anyhow we hope they could strengthen its weak increasing participation.

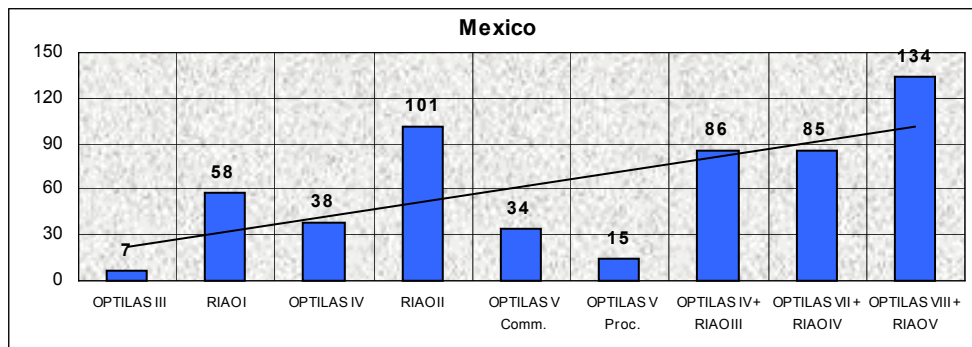


### IV.3.5 - Chile.



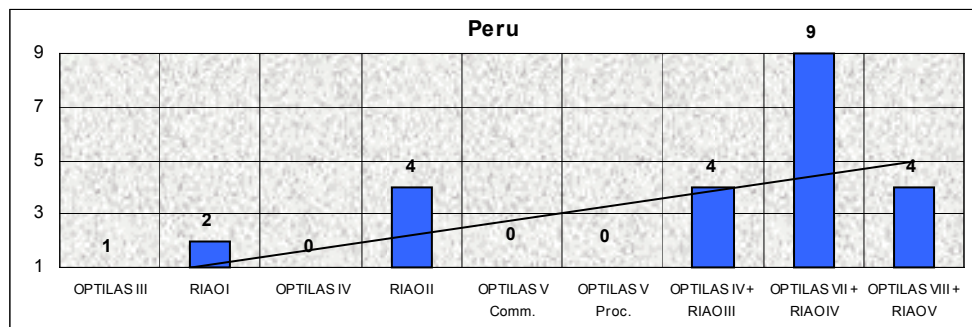
Even if the participation of the Chilean optical community has a constant mean value, this is not a real picture of the optical production of this country. The only conclusion we can draw is a weak share to these meetings and we hope for an increasing participation in the future.

### IV.3.6 - Mexico.



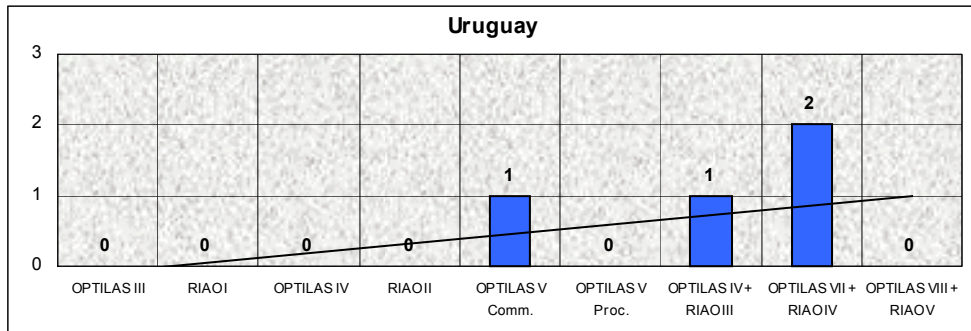
This optical community has always participated with an important contribution to these meetings. This share shows the importance of this community, its high academic level and its decision of being always present as an important part of the greater Latin American optical community.

### IV.3.7 - Peru.



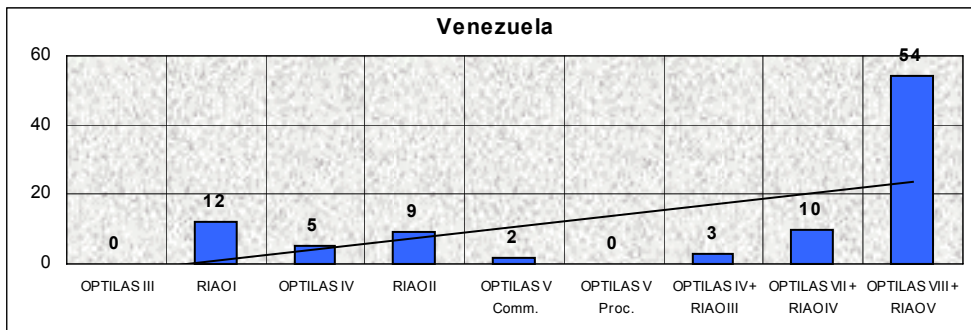
Peru has a rather small group of people working in optics. Nevertheless they have contributed to almost all these meetings and the number of people making researches in optics and the contributions show an increasing of their academic level. We hope they could strengthen this increasing participation.

### IV.3.8 - Uruguay.



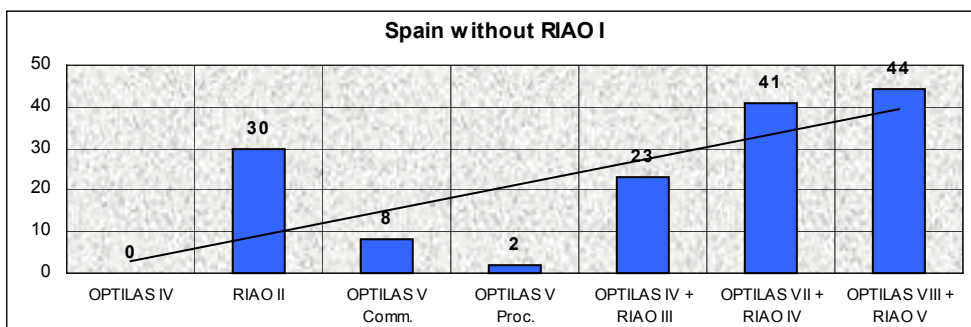
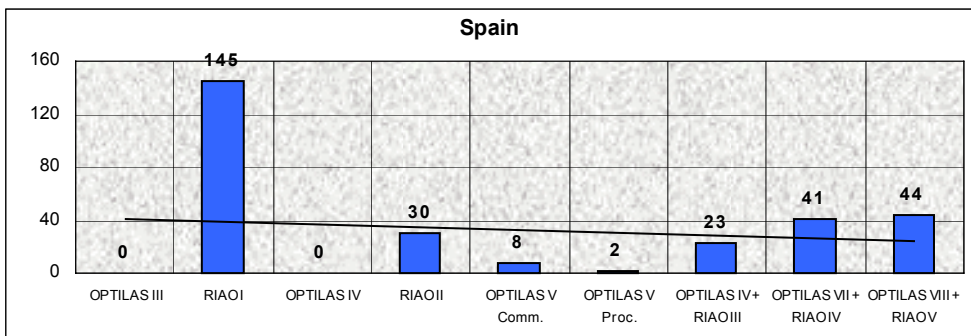
In Uruguay there are some small groups working in optics, with a high academic level. They don't participate regularly in these meetings. We wish to have a systematic contribution of this community in these Latin American meetings.

### IV.3.9 - Venezuela.



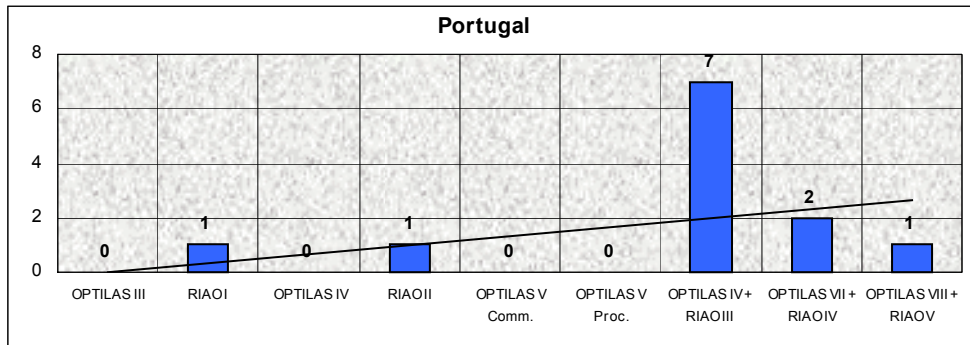
In Venezuela there is an important optical community with a rather large production. The contribution of this community in the Latin American meetings has not been very important. Nevertheless in the meeting of Margarita Island its share is important. We wish this meeting were the beginning of a stronger participation of our Venezuelan colleagues in Latin American meetings.

### IV.3.10 - Spain.



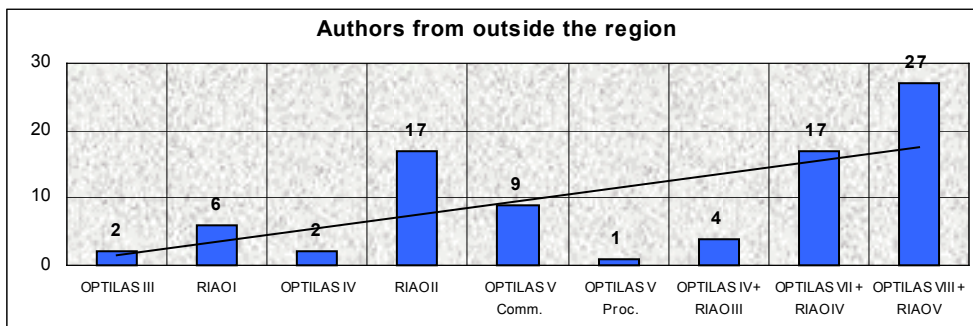
Spain is a special case among the Spanish and Portuguese speaking communities. First of all, they have organized one of the first ICO Meeting in 1953 and ICO XI in 1978; second, the first RIAO had an important participation of people, probably because it was organized by that country; and third they produce the most important quantity of papers. Spain has also an important participation in almost all Latin American meetings. It was thus surprising to see a decreasing participation of this country. But after seeing the strong participation in RIAO I it was obvious that this singularity changed the real situation. A new graphic was made without this datum and it was possible to have a situation nearer the reality. In the last three meetings Spain has participated in an increasing way and it is desirable an important growth of communications from the Spanish colleagues.

#### IV.3.11 - Portugal.



Unfortunately, interconnections with the Portuguese optical community are not nowadays as fluid as desired. Some colleagues apparently think these meetings are a Latin American and Spaniard business, for that reason they don't participate. Our colleagues of Portugal must know that they are an important part of the Ibero American community. Therefore it is desirable a greater participation of Portugal in the next meetings.

#### IV.3.12 - Contributions from outside de region.



It is important to see the increasing participation of people from outside the region because this gives, probably, a measure of the visibility of these kinds of meetings. Then, we consider a positive thing this phenomenon.

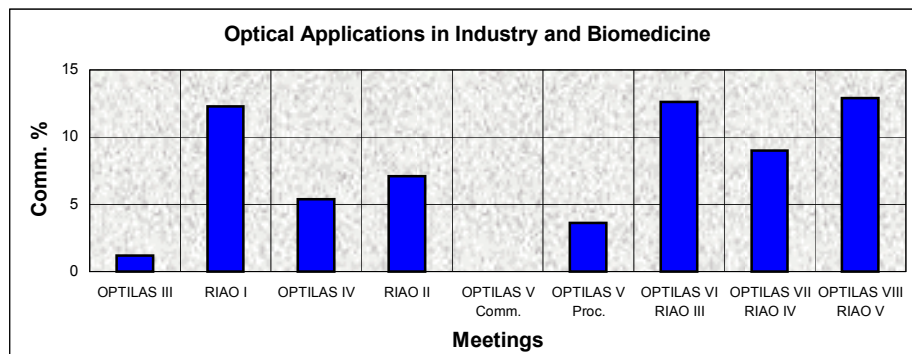
#### IV.4 - Distribution of Communications by Topics in OPTILAS and RIAO Meetings.

Another way to understand the evolution of optical research in Latin America is to analyze the evolution of the quantity of communications submitted on each topic during the last sixteen years.

It was studied the evolution of the distribution of communications about the following topics presented in regional meetings:

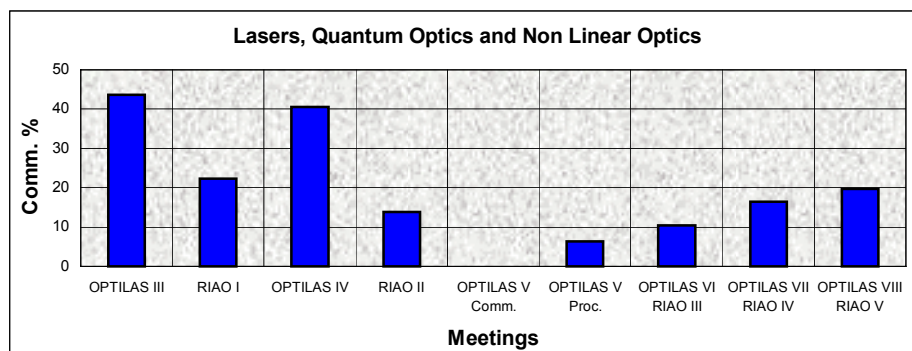
N <sup>o</sup>	TOPICS
1	Optical Applications in Industry and Biomedicine
2	Lasers, Quantum Optics and Non Linear Optics
3	Optical Metrology and Interferometry
4	Optical Systems and Instruments
5	Opoelectronics Devices, Fiber Optics and Communications
6	Optical Spectroscopy
7	Physical Optics, Diffraction, Scattering, etc.
8	Atmospheric Optics, LIDAR.
9	Condensed Matter, Optical and Optoelectronics Materials, Thin Films
10	Color, Vision and Radiometry
11	Optical and Digital Image Processing
12	Ultrafast Optics
13	Didactics of Optics
14	Laser-Matter Interaction

#### IV.4.1 - Optical Applications in Industry and Biomedicine.



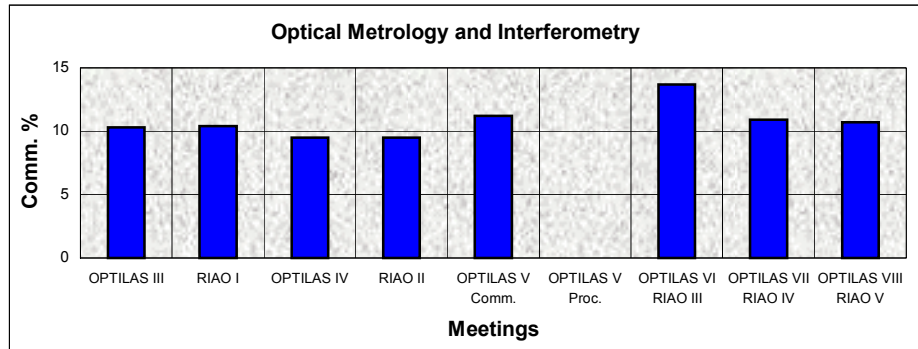
Considering the time interval 1988 - 2004 there is an increasing number of communications presented on this topics, nevertheless in the last three meetings this number remain approximately unchanged.

#### IV.4.2 - Lasers, Quantum and Non Linear Optics.



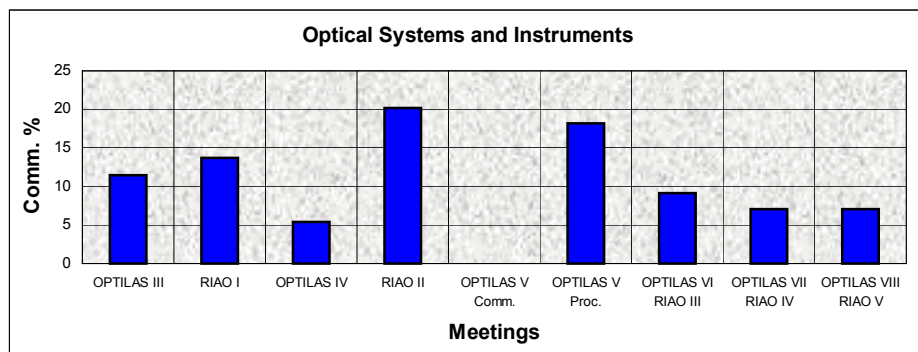
Taking into account the interval studied it seems a decreasing amount of communications on this subject, however, considering the three joint meetings (1998 - 2004) this number is clearly increasing.

### IV.4.3 - Optical Metrology and Interferometry.



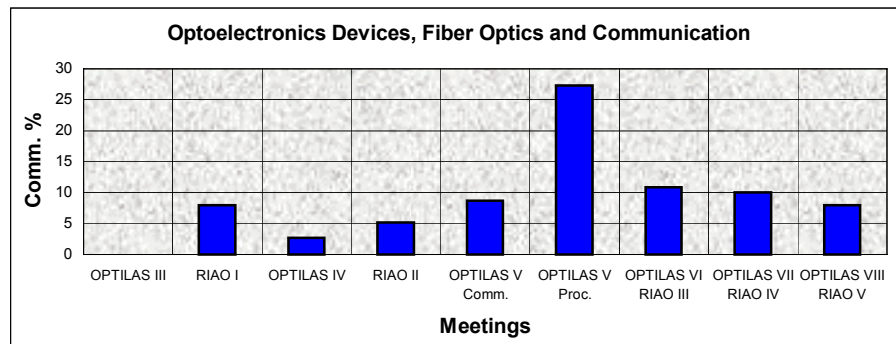
It is interesting to observe that the proportion of communications on this topics remain unchanged during the time interval.

### IV.4.4 - Optical Systems and Instruments.



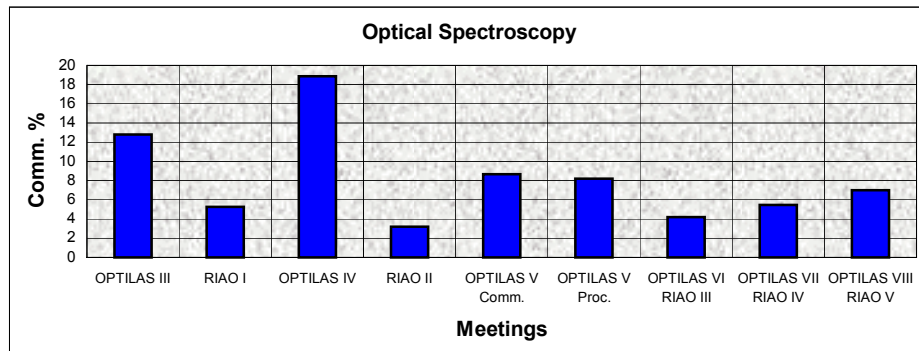
With regard to the time interval 1988 - 2004, it seems unchanged the mean value of communications on this topics, nevertheless in the last three meetings this number softly decrease.

### IV.4.5 - Optoelectronics Devices, Fiber Optics and Communications.



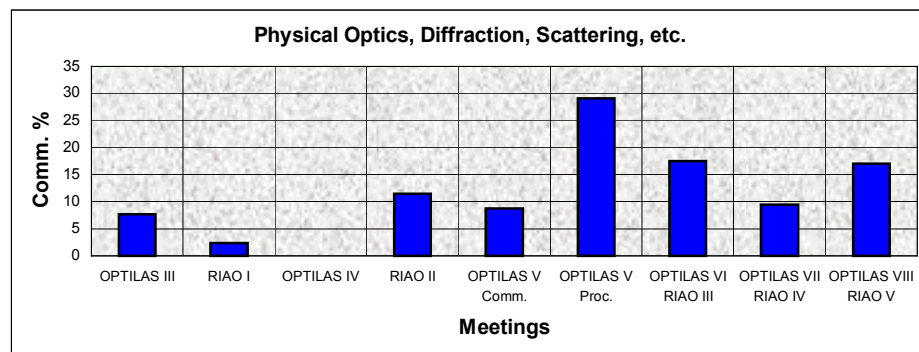
The contribution in these topics becomes to have some importance from 1995; nevertheless it is not easy to understand its behavior in the last three meetings.

#### IV.4.6 - Optical Spectroscopy.



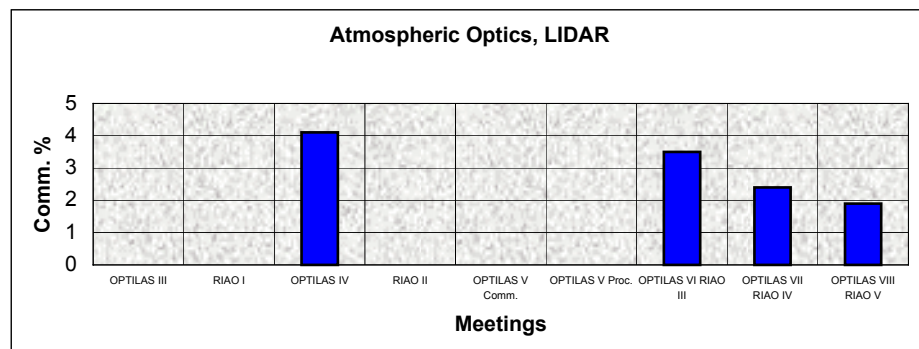
The communications about optical spectroscopy remain around 7% except in 1988 and 1993. It is not easy to explain this anomaly.

#### IV.4.7 - Physical Optics, Diffraction, Scattering.



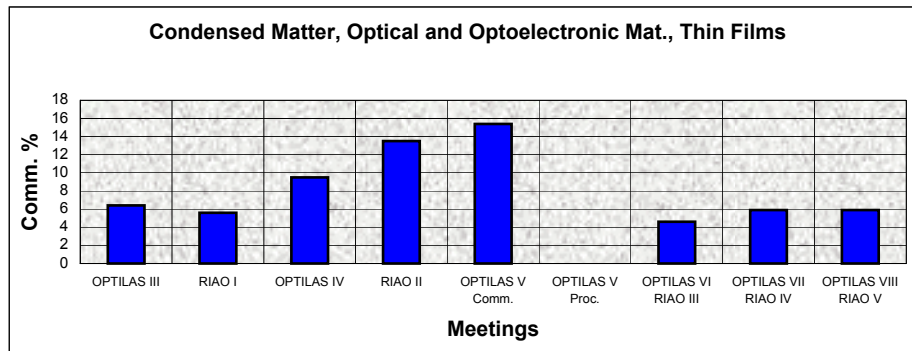
From 1995 there is a clear contribution on these subjects in the studied meetings, after this year the contribution to this topics fluctuate between 10% and 18% of the total communications submitted.

#### IV.4.8 - Atmospheric Optics, LIDAR.



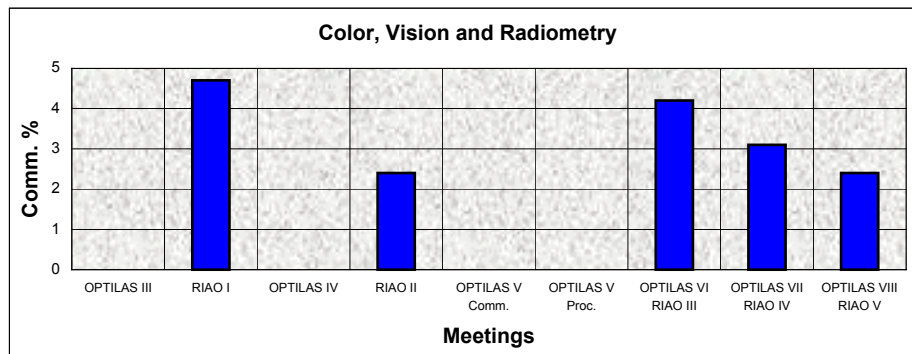
This is a topic that recently appear in Latin American Meetings and after a careful analysis of communications presented in this subject, it is clear that they come from only two or three laboratories of the region.

**IV.4.9 - Condensed Matter, Optical and Optoelectronic Materials, Thin Films.**



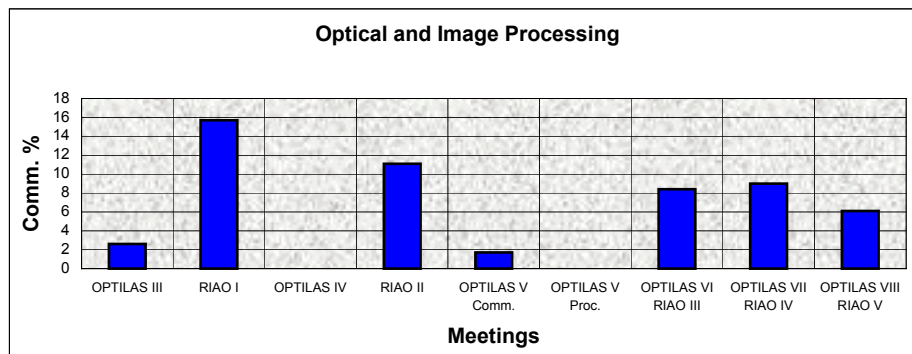
The communications concerning this topic have a peculiar behavior. From 1988 to 1995 the proportion is clearly increasing. From 1995 to 1998 there is a great fall and after that there is another increasing period. It is not easy to understand this behavior, however it is probably due to the Meetings chosen by the people to submit their papers.

**IV.4.10 - Color, Vision and Radiometry.**



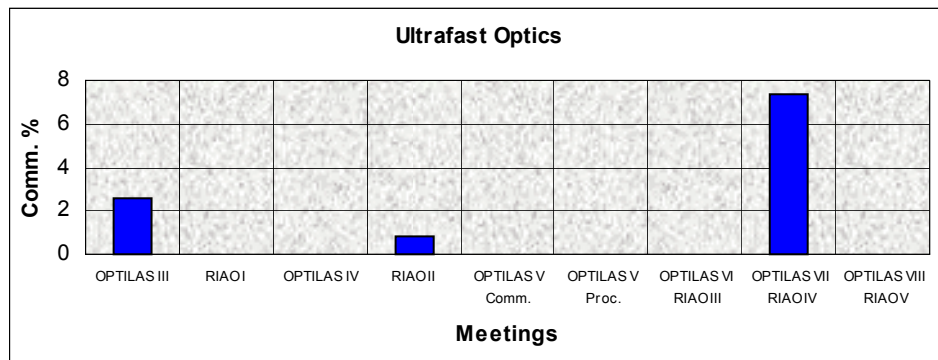
This is another topic not so much present in this kind of meetings. The people working in these subjects choose another meetings therefore sometimes there are some communications and in other meetings there are no presentations. In the last three meetings this number clearly decrease.

**IV.4.11 - Optical and Digital Image Processing.**



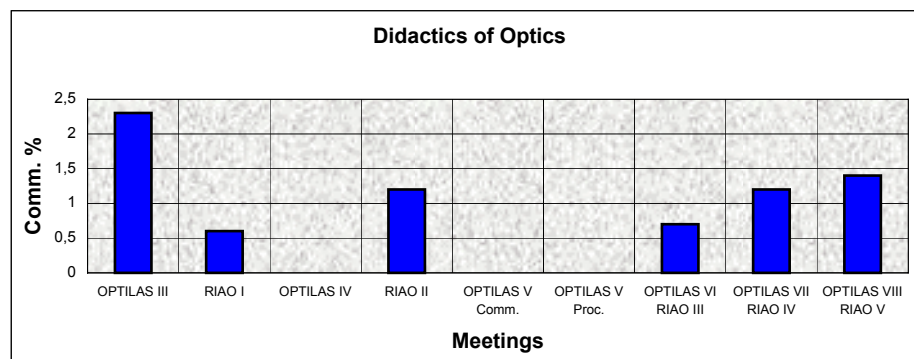
The communications about this topic has an oscillatory behavior with a steady 7% in the last three meetings.

#### IV.4.12 - Ultrafast Optics.



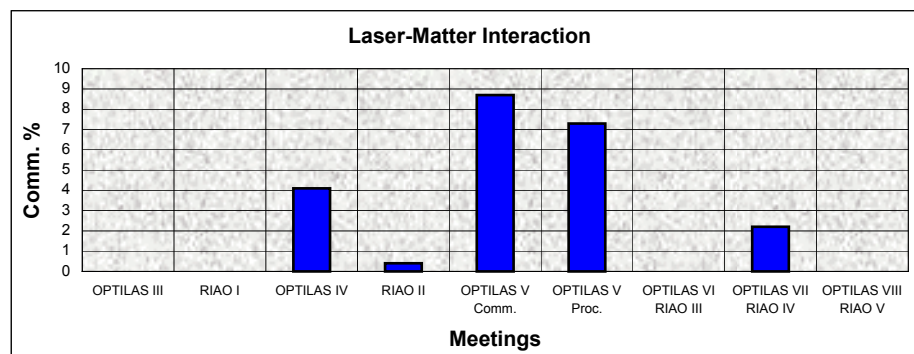
It is impossible to draw a conclusion from the communications presented on this topic, probably because it is very new subject of research in the region.

#### IV.4.13 - Didactics of Optics.



The communications about this topic has a not easy to explain behavior, however it seems a clear increase in the last three meetings.

#### IV.4.14 - Laser-Matter Interaction.



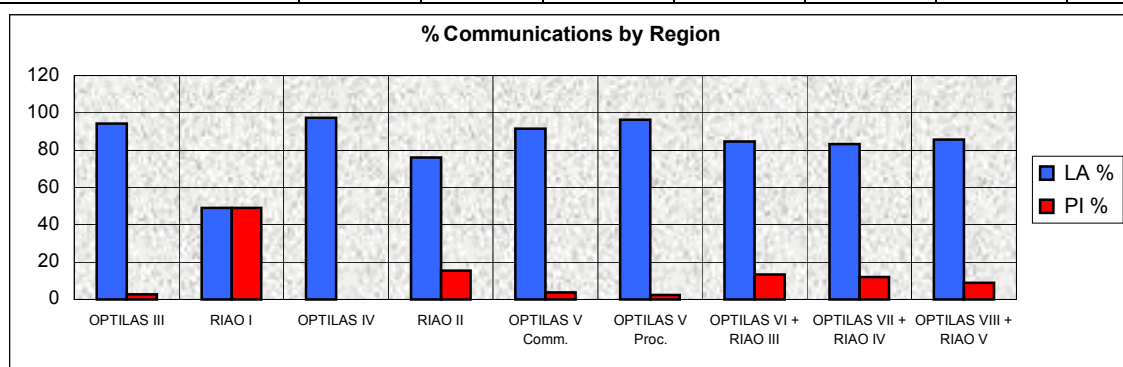
The communications concerning this topic have also a peculiar behavior. It is not easy to understand this behavior, however it is probably due to the Meetings chosen by the people to submit their papers in the same way that the Condensed Matter topics.

#### IV.5 - Contribution of Latin American and Iberian countries in OPTILAS and RIAO Meetings.

It is interesting to compare the evolution of the number of communications submitted to OPTILAS and RIAO Meetings by the people living in both sides of the Atlantic: Latin America (LA) and the Iberian countries (PI).



MEETINGS	COUNTRY	YEAR	TOTAL	LA	LA %	PI	PI %
OPTILAS III	Argentina	1988	68	66	94.3	2	2.9
RIAO I	Spain	1992	298	146	49.0	146	49.0
OPTILAS IV	Mexico	1993	80	78	97.5	0	0.0
RIAO II	Mexico	1995	202	154	76.2	31	15.3
OPTILAS V Comm.	Cuba	1995	206	189	91.7	8	3.9
OPTILAS V Proc.	Cuba	1995	80	77	96.3	2	2.5
OPTILAS VI + RIAO III	Colombia	1998	222	188	84.7	30	13.5
OPTILAS VII + RIAO IV	Argentina	2001	357	296	83.2	43	12.1
OPTILAS VIII + RIAO V	Venezuela	2004	501	429	85.6	45	9.0



LA: Latin American countries, PI: Countries in the Iberian Peninsula

From the comparison drawn among the communications submitted by the Latin America and the Iberian Peninsula countries, it is clearly seen a preponderance of Latin America (near a mean of 10 times greater), except in RIAO I, where both regions equaled contributions. It is not easy to draw clear conclusions from this fact. It could either be related to the grants or funds gathered to travel or to the importance given to this kind of meetings.

#### IV.6 - Invited lecturers to OPTILAS and RIAO Meetings.

As regards the invited lecturers, it is very interesting to notice the wide variety of nationalities beyond the region. The choice of these lecturers was made either on the basis of their experience as researchers on a specific subject or due to the organizers' need to invite well-known colleagues, recognized in their fields.

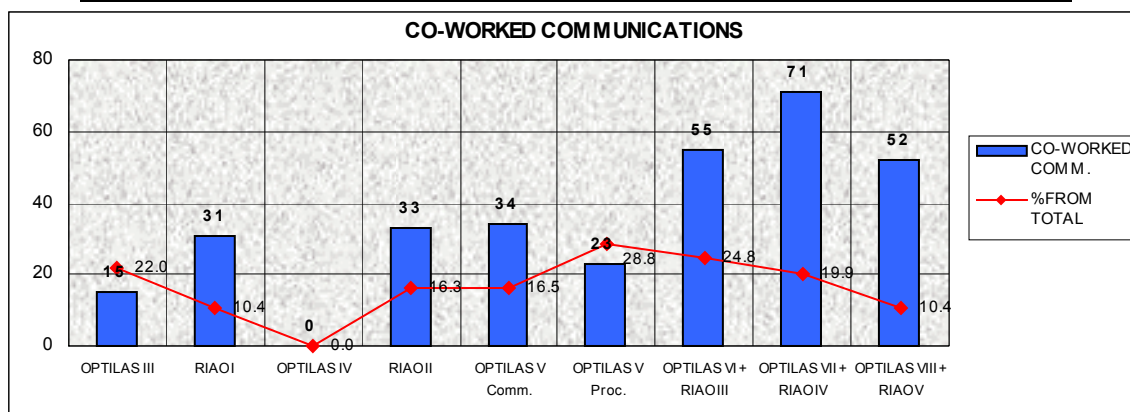
#### IV.7 – Co-worked communications presented in these meetings.

Finally, it is interesting to point out the evolution of co-working among colleagues from Latin America and other different countries (Spain and Portugal included).

Some facts may arise from the analyzed results: the increase in the collaboration among Latin American countries has apparently decreased these last times. The same process happens with the collaboration between Latin America and Iberian groups. The collaboration among colleagues in the region and outside seems continue to be increasing. Nevertheless, the most important conclusion is that seems there are no valid conclusions. Anyhow, we think it is crucial for the development of the Latin America optical community to increase the cooperation between Latin American Laboratories. So we have a serious target: to create a Latin American Laboratory Network, which would be able to increase the exchange of researchers as well as the use of optical facilities in those well equipped laboratories. In this way, we will try to mitigate the economical problems of our region and we will have the possibility to continue the growth of our research activities.

Furthermore, the Latin American optical community has developed many topical schools in different countries. Nevertheless we think also very important to have as another co-operation target, a Latin American School of Optics.

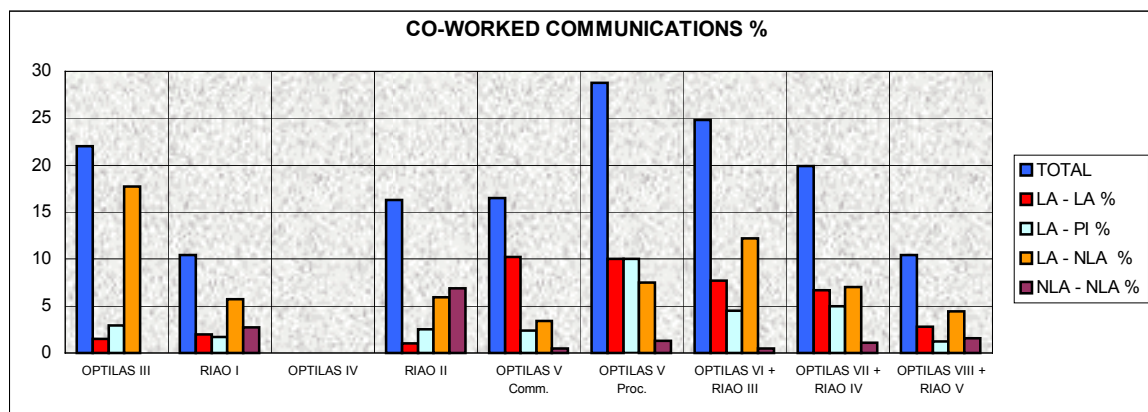
MEETINGS	COUNTRY	YEAR	CO-WORKED COMM.	% FROM TOTAL
OPTILAS III	Argentina	1988	15	22.0
RIAO I	Spain	1992	31	10.4
OPTILAS IV	Mexico	1993	0	0.0
RIAO II	Mexico	1995	33	16.3
OPTILAS V Comm.	Cuba	1995	34	16.5
OPTILAS V Proc.	Cuba	1995	23	28.8
OPTILAS VI + RIAO III	Colombia	1998	55	24.8
OPTILAS VII + RIAO IV	Argentina	2001	71	19.9
OPTILAS VIII + RIAO V	Venezuela	2004	52	10.4



#### IV.7.1 – Co-worked communications by origin of authors.

MEETING	COUNTRY	YEAR	TOTAL CO-WORKED %	LA - LA %	LA - PI %	LA - NLA %	NLA - NLA %
OPTILAS III	Argentina	1988	22.0	1.5	2.9	17.7	0.0
RIAO I	Spain	1992	10.4	2.0	1.7	5.7	2.7
OPTILAS IV	Mexico	1993	0.0	0.0	0.0	0.0	0.0
RIAO II	Mexico	1995	16.3	1.0	2.5	5.9	6.9
OPTILAS V Comm.	Cuba	1995	16.5	10.2	2.4	3.4	0.5
OPTILAS V Proc.	Cuba	1995	28.8	10.0	10.0	7.5	1.3
OPTILAS VI + RIAO III	Colombia	1998	24.8	7.7	4.5	12.2	0.5
OPTILAS VII + RIAO IV	Argentina	2001	19.9	6.7	5.0	7.0	1.1
OPTILAS VIII + RIAO V	Venezuela	2004	10.4	2.8	1.2	4.4	1.6

DEFINITIONS: **LA-LA** = Co-worked communications carried out between Latin American colleagues. **LA-PI** = Idem between Latin American and Iberian colleagues. **LA-NLA** = Idem between Latin American and non-Iberian colleagues. **NLA-NLA** = Idem between non Latin American colleagues.



## V – Publications from Latin American, Spanish and Portuguese authors from 1974 to 2003.

Sources from the Science Citation Index from 1974 to 08/31/2000. A paper is considered from a country if at least one of the authors belongs to that country. Uruguay, Peru, Venezuela y Chile from 1974 to 28/05/2003.

JOURNALS CONSULTED	ARGENTINA	BRASIL	COLOMBIA	CUBA	CHILE	MEXICO	PERU	URUGUAY	VENEZUELA	ESPAÑA	PORTUGAL	TOTAL
OPTICAL ENGINEERING	32	12	6	0	0	67	0	3	3	84	5	212
APPLIED OPTICS	128	98	6	0	8	216	1	11	18	394	28	908
JOSA A (*)	9	5	0	0	0	22	0	2	7	53	2	100
JOSA A (**)	15	7	4	4	2	50	1	2	1	95	4	185
JOSA B (***)	16	47	0	0	3	27	0	1	8	91	4	197
OPTICS LETTERS	21	70	1	0	0	70	0	3	3	149	10	327
J. OF MODERN OPTICS	62	22	4	0	2	57	0	0	3	143	4	297
IEEE J. OF QUANT. ELECTR.	23	52	0	0	0	6	0	0	0	60	4	145
OPTICS COMMUNICATIONS	94	140	12	0	11	141	4	14	17	340	13	786
OPTICS AND LASER TECH.	15	13	4	2	1	7	0	1	2	11	0	56
PURE AND APPLIED OPTICS	4	1	0	0	0	1	0	1	0	12	1	20
JOURNAL OF OPTICS A	0	0	0	0	0	0	0	0	0	4	0	4
JOURNAL OF OPTICS B	0	3	0	0	2	1	2	1	1	8	0	18
JOURNAL OF OPTICS	8	0	0	0	0	1	0	0	1	44	0	54
OPTICS AND LASER ENG.	3	3	0	0	1	11	2	0	0	4	0	24
OPTICAL & QUANT. ELECTR.	3	26	0	0	0	7	0	0	0	46	7	89
OPTIK	100	3	16	0	4	32	0	0	1	74	0	230
APPL. PHYS. A	12	30	0	2	0	20	0	0	1	122	6	193
APPL. PHYS. B (LAS. & OPT.)	7		0	1	0	7	0	0	1	26	2	44
B (PHOTOPHYS. & LASER)	5	26	0	0	0	1	0	0	1	14	0	47
APPLIED PHYSICS LETTERS	21	244	3	9	10	94	1	2	11	413	27	835
APPLIED SPECTROSCOPY	8	18	0	2	0	3	0	1	26	87	5	150
CHEMICAL PHYSICS	25	57	0	0	6	13	0	1	9	243	24	378
CHEMICAL PHYSICS LETTERS	104	214	2	2	38	113	0	11	22	598	81	1185
EUROPHYSICS LETTERS	41	85	6	1	15	20	0	2	7	241	31	449
IEEE TRANS. ON PLASMA SC.	18	21	0	0	13	4	0	0	0	5	13	74
J. OF QUANT. SPECT. & RAD. TRANSF.	16	48	0	0	0	4	0	0	0	67	10	145
J. OF APPLIED PHYSICS	80	609	24	35	14	186	6	1	102	863	110	2030
J. OF CHEMICAL PHYSICS	187	249	2	7	46	294	0	5	63	992	71	1916
JOURNAL OF LUMINESCENCE	8	62	1	1	0	21	0	0	0	119	44	256
J. OF PHYSICAL CHEMISTRY	123	624	0	6	42	69	1	2	40	514	73	1494
J. OF PHYS. CHEMISTRY A, B.	41	68	2	5	42	55	1	9	40	359	57	679
J. OF PHYS. A, B, C, D, E, F, G.	414	624	13	16	67	308	2	3	76	1183	207	2913
OPTICS AND SPECTROSCOPY	0	0	0	0	0	1	0	0	0	0	2	3
SOLID STATE COMMUN.	141	596	15	17	43	149	1	1	55	430	26	1474
PHYSICAL REVIEW A (1)	119	436	4	1	20	300	3	5	21	347	23	1279
PHYS. REVIEW LETTERS (2)	60	250	16	5	14	461	1	4	12	135	20	978
<b>TOTALES</b>	<b>1963</b>	<b>4763</b>	<b>141</b>	<b>116</b>	<b>404</b>	<b>2839</b>	<b>26</b>	<b>86</b>	<b>552</b>	<b>8370</b>	<b>914</b>	<b>20174</b>

(\*) JOURNAL OF THE OPTICAL SOCIETY OF AMERICA A (OPTICS AND IMAGE SCIENCE)

(\*\*) JOURNAL OF THE OPTICAL SOCIETY OF AMERICA A (OPTICS AND IMAGE SCIENCE AND VISION)

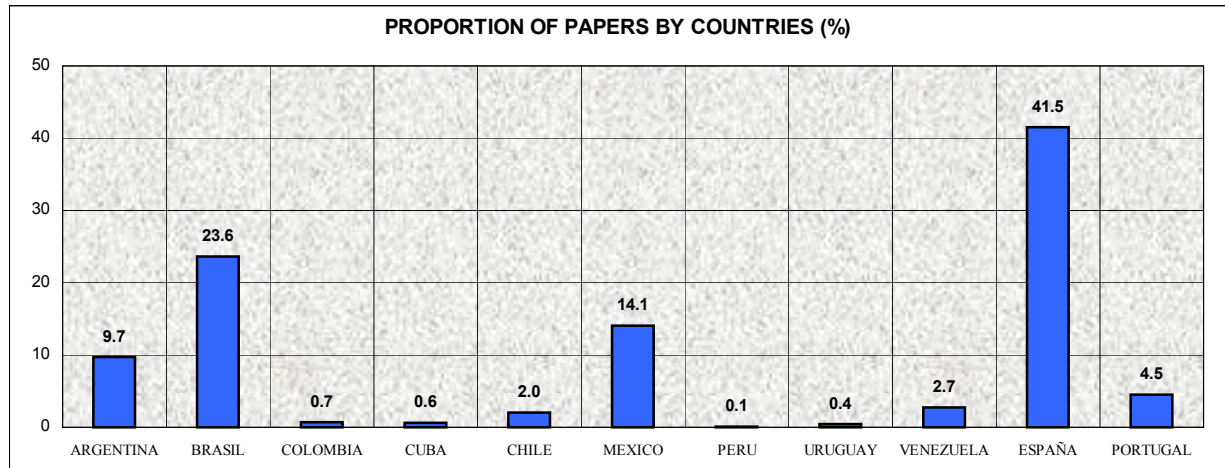
(\*\*\*) JOURNAL OF THE OPTICAL SOCIETY OF AMERICA B (OPTICAL PHYSICS)

(1), (2) FROM 1974 to 2003

I have no available current information from the other Latin American countries.

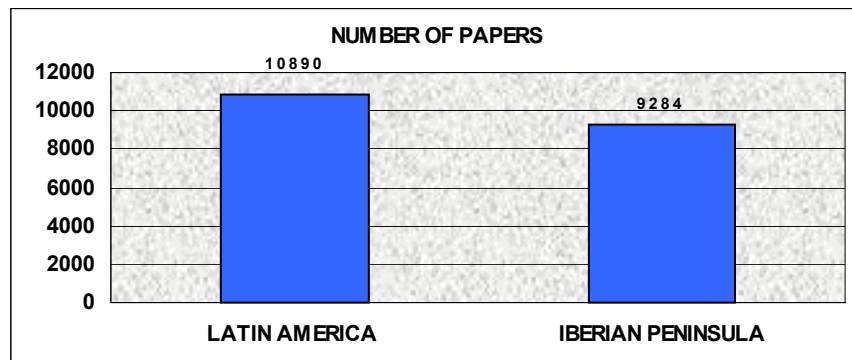
### V.1 – Totals of papers published by country.

COUNTRIES	ARGENTINA	BRASIL	COLOMBIA	CUBA	CHILE	MEXICO	PERU	URUGUAY	VENEZUELA	ESPAÑA	PORTUGAL	TOTAL
PAPERS	1963	4763	141	116	404	2839	26	86	552	8370	914	20174
%	9.73	23.62	0.7	0.6	2	14.07	0.13	0.43	2.7	41.49	4.53	100



### V.2 – Totals of papers published by region.

REGION	LATIN AMERICA	IBERIAN PENINSULA
PAPERS	10890	9284
PAPERS %	54 %	46 %



If we take a look at the publications from Latin American countries, Spain and Portugal, we can see that the amount of Latin American contributions is almost identical to that from Spain and Portugal.

Other important conclusions drawn from the comparison between the participation of Latin American countries in the regional meetings and the contributions in specialized reviews are the following:

- An important contribution from Brazil to specialized reviews in optics and photonics that has no relation with its participation in regional meetings. Brazil has reached near 24% of the publications while the mean contribution in the last three regional meetings are only 10% with a maximum of 32% in III OPTILAS (Argentina, 1988).

- Mexico, whose publications have reached 14%, has presented a mean of 31% of communications in the last three meetings, with a maximum of 53% in II RIAO (Mexico, 1995).
- Argentina contributes to the three regional events with a mean of 21% and publishes somewhat less than 10% with a maximum of 41% in III OPTILAS (Argentina, 1988).
- Spain hands in 11% of the mean communications to the last regional meetings and publishes somewhat less than 42%. The maximum of Spain was in I RIAO (Spain, 1992) with 50% of communications.
- Colombia and Cuba show similar results concerning the published papers, with 0.7% and 0.6% respectively, whereas the situation in regional meetings is quite different, the means of the three last meetings are 13% and 4% respectively, with maxima of 16% of Venezuela (2004) and 50% (Cuba, 1995).
- Venezuela has balanced results, it has published near 3% of papers and its mean contribution to the last three meetings is 5% with a maximum of 11% to the Margarita Island meeting (2004).
- Portugal contributes with 5% of the publications and the mean value of three last meetings is 1.3% of communications. The maximum of this contribution was in Colombia in 1998.

These comparative results show how each national community decides to spread their achieved results.

Besides, all the Latin American community agrees that Brazil and Portugal as an important part of this community need to strength their forces in forthcoming future common activities.

## VI – LATIN-AMERICAN OPTICAL SOCIETY?

Before answering this question, we must have a look at the organizational level of the optical communities in the Iberian countries. As far as we know, the countries mentioned below have active groups that work on optics or photonics.

COUNTRY	Society, Division, etc.	ICO Member
Argentina	CAO-1982; DO-DFF-AFA-1005	CTO-1997
Brazil	CBO-1984	CTO-1984
Colombia	RCO	CTO-1990
Cuba	SCF	CTO-1993
Chile	SOCHIFI	
Ecuador		CTO-2005
Mexico	AMO	CTO-1972
Peru	SOPERFI	
Portugal		CTO-1978 ?
Spain	CEO-1950; SEDO-1968	CTO-1948
Uruguay	SUF	
Venezuela	SVF	CTO-1997

As was mentioned above, a system of organization with academic goals was established in Latin America 20 years ago. Moreover, a new system somehow different was set up 12 years ago, including Latin America and Iberian countries. Both scientific meetings were held in 1998 with the following objectives:

- Both events would meet again but keeping their identities.
- In each meeting the organizers for the two forthcoming meetings must be chosen.
- To propose the creation of a Latin American Optical Society.

It is important to point out another attempts to create regional organizations, which had relative success:

- Optical and Laser Applications Network (RAOL, 1997) (integrated with researchers from Argentina, Brazil, Uruguay and Venezuela).
- Multipurpose Optical Network (MON, sponsored by the ICTP, 1996).
- Argentine Optical Laboratories Network (Sponsored by the National Research Council, 2002).

Anyway, it seems this is the moment to start discussions that will lead to the organization of a society which would get together all the people working in optics that attend regularly to these kinds of meetings.

Doubtless, this society ought to have an important degree of freedom and at the same time it should guarantee not only to maintain the level of commitment in the national groups, but also to foster the level of commitment towards the development of the optics in their own countries and in relation to the region.

These points must necessarily be the target of new Latin American Optical Society:

- Creation of a Latin American Network of Optical Laboratories. This network would be able to increase the exchange of researchers as well as the use of optical facilities in those well-equipped laboratories. In this way, we will try to mitigate the economical problems of our region and we will have the possibility to continue the growth of our research activities.
- Creation of a Latin American School of Optics. The Latin American optical community has developed many topical schools in different countries. Actually, some optical societies have proposed to collaborate economically with this future School. We must be organized so that the Latin American Optical Community could take advantage of this School.
- Make the necessary effort to organize ICO'20 Meeting in Latin America. We consider that it could be very important for the region to organize next ICO Meeting in Latin America. This would be a significant contribution of ICO, because it will foster the optical activities in Latin America, and will help to overcome the current economic crisis.
- Increase collaborative research, among Latin American people, as well as with colleagues of Spain, Portugal and other countries.

The increasing interest of the most important Optical Societies of the world (SPIE, OSA, EOS, etc.) to interact with Latin-American optical communities is highly promising. Anyhow, we are a small community in comparison to the optical communities of developed countries where those Societies are stronger. On the other hand, with obvious differences, the majority of Latin-American optical communities have similar interests; therefore it is interesting to analyze the possibility of creating a Latin-American Optical Society. In this way, the Latin-American optical community would have a representative group of colleagues to interact with their Executive Committee.

## **VII – OPTICAL RESEARCH IN LATIN AMERICA NOW.**

### **VII.1 - How large is the Optical Community in Latin America?**

No accurate information about the quantity of people (PhD and MSc) working in optics in the region is available, anyhow it can be estimated: Brazil: 800, Mexico: 450, Argentina: 250, other countries: 400. That is to say, 2000 maximum.

There are several important Optical Research Groups in some Latin American countries. The available information concerns about the most important Latin American optical communities: Brazil, Mexico and Argentina.

In the first one, there are two important projects: the Optics and Photonics Center (COF) and the Synchrotron Light National Laboratory (LNLS) both located in Sao Paulo State. In this State there are also several of the most important optical research groups of Brazil, among them, we can point out the Physics Institute of San Carlos (Sao Paulo University (USP)), Physics Institute of the USP, Campinas University (UNICAMP), Technical Aeronautical Center (CTA), Nuclear and Energy Research Institute (IPEN), Technological Research Institute of Sao Paulo State (IPT) and Research and Development Center of TELEBRAS.

Many other universities have important educational and research programs in optics, for example: National University of Minas Gerais (UFMG), National University of Rio Grande do Sul (UFRGS), National Center of Technological Education of Parana, National University of Rio de Janeiro (UFRJ), etc.

In Mexico there are three well known institutes: National Institute of Astrophysics, Optics and Electronics (INAOE), University and Research Center of Ensenada (CICESE) and Optical Research Center of (CIO).

Many national universities in different country regions have educational and research programs in

optics. For instance, Sonora, Nueva Leon, Puebla, Ciudad de Mexico D. F., San Luis Potosi, Morelos, Michoacan, etc.

In Argentina there are some important optical groups located in a relatively small zone in and near Buenos Aires city. They form the most significant optical researchers' cluster of the country: Optics and Laser Laboratories of Atomic Energy Agency (LOL-CNEA), Lasers and Applications Research (CEILAP), Physics Department of the Science Faculty, Buenos Aires University (DF-FCEN-UBA) and Physics Department of the Engineering Faculty, UBA (DF-FI-UBA). The largest institute of optics is the Optical Research Center (CIOP) located in the outskirts of La Plata city 60km from south Buenos Aires.

Some national universities in different states have important research programs in optics: Center of Buenos Aires State National University (UNCPBA), Rosario National University (UNR), Tucumán National University (UNT), etc.

### **VII.2 - Which are the major optics-related initiatives that are underway or will take place in the near future?**

Probably the most important initiatives are related to joint activities, for example, the V RIAO (Iberoamerican Meeting of Optics) and the VIII OPTILAS (Latin American Meeting of Optics, Lasers and their Applications) that will be held in Venezuela, in October 2004.

In Mexico and Brazil, the sectorial funds are an interesting initiative directed towards a larger integration between knowledge and industry.

Perhaps one of the major optics related initiatives that will be occurring in the near future is a Latin American School of Optics that would be organized with the cooperation of OSA, SPIE, CLAF, ICTP and NSF. Another important initiative would be the creation of a Latin American Network of Optical Laboratories.

Probably the way to achieve all these initiatives is to get going the Latin American Optica Society for co-ordinate the above-mentioned proposals.

Each country has some isolated milestones with regard to the historically international trends. However, the most important milestone of the Latin American optics community is its own existence and growth.

### **VII.3 - How difficult is to get funding for optics programs?**

In Latin American countries it is very difficult to get funding not only for optics programs but also to perform research in any field of science and technology. Brazil and Mexico are the countries in the region that invest most money in the optical field. Particularly, Brazil is the only Latin American country that invests in I+D more than 1% of GNP. México and Argentina about 0,4 %.

In Brazil there is a shifting of funds from science to some economical sectors. However, it is possible to obtain funds for not very expensive applied projects. The situation in Mexico is more or less the same. In Argentina to get funding is, at the moment, extremely hard. We can say that most optics programs have no funds to develop a normal work.

Other Latin American countries are probably in the same situation or worst.

In Argentina, Brazil and Mexico there are some laboratories that have state of the art instrumentation such as lasers, electro optical devices and other optical components to do research. However, the situation in Argentina has been seriously deteriorated in the last years due to the economical situation.

In Brazil and Mexico as well as in Argentina, whenever it is not possible to obtain funds for buying new instruments, researchers make their own instruments or change to theoretical issues.

With poor funds it is essential to have persistence and creativity in all sense, because "less money always spells more bureaucracy".

It is not easy to forecast the situation for the next years, but it seems problems will grow particularly with respect to fundamental research. To receive funds for Applied Research seems that will have a better chance to receive more funds.